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TOTAL ORGANIC CARBON IN WATERS OF THE SOUTH-WESTERN ATLANTIC ANTARCTIC DURING THE SUMMER-AUTUMN SEASON OF 1990

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ABSTRACT. The distribution of total organic carbon (TOC) was studied during the 25th cruise of R/V «Akademik Knipovich» (January-April 1990) at sections through the Polar Frontal Zone along 40°W in January and April, at section from the Polar Frontal Zone to the South Orkney Islands, and on the South Georgia shelf. Total organic nitrogen, nitrates, nitrites, ammonia, phosphates, and silicates were also determined. Increased concentrations of TOC were observed in the photic layer and in the layer of organic matter accumulation — at the vertical boundaries between the water masses. The waters of the South Georgia shelf were characterized by even distribution of TOC — about 0.2 mgC L^{-1}.

Key words: total organic carbon, total organic nitrogen, Polar and Secondary Frontal Zones, accumulation and transformation of organic matter.

Introduction

The Antarctic Intermediate Water in the Polar Frontal Zone is the main hydrological factor which causes advection of organic matter outside the Southern Ocean. At low latitudes the Antarctic Intermediate Water spreads to the north in the layer of 800-1200 m up to 10°N in the Atlantic Ocean (Cooksa 1983). These waters transport along organic matter produced in the Antarctic ecosystem during the spring-summer season. Transported to the north, organic matter is oxidized. Consequently, the zones of accumulation of the organic matter are characterized by high values of organic carbon (C_{org}) and low concentrations of dissolved oxygen.

The oxidation of organic matter at the isopycne surfaces of $\sigma_t = 27.0\text{-}27.2$ corresponding to the vertical boundaries of the Antarctic Intermediate Water was described by Menzel and Ryther (1968) for 8°S region in the Atlantic Ocean and by Takahashi et al. (1985) for the Arabian Sea. Practically, there were no studies concerning the processes of production and destruction of organic matter in the area of the Antarctic Intermediate Water formation and the adjacent Antarctic waters, though processes of production, accumulation and transformation of organic matter in waters adjacent to the Polar Frontal Zone are very important for understanding of the biogeochemical turnover of carbon in the Southern Ocean.

Investigations conducted in the Polar Frontal Zone during spring of 1988 showed that increased surface concentrations of dissolved organic matter, up to 6.0-8.0 mg L^{-1}, were observed in dynamically active regions of the Polar Frontal Zone — meanders and eddies of the Antarctic Circumpolar Current and at the vertical boundaries of the Antarctic Intermediate Water (Dafner 1992). The new production calculated on the basis of silicate consumption in the point located near the southern boundary of the Polar Frontal Zone — Polar Front was about 1.0 gC $(m^2\ day)^{-1}$ (Mordasova et al. 1990; Dafner and Mordasova 1994).

Another area of organic matter accumulation in Antarctic waters southward of the Polar Frontal Zone coincides with the upper boundary of the Antarctic Bottom Water at depth of 200 m. Due to the difference in density between the Antarctic Intermediate Water and Antarctic Bottom Water, the layer with sharp vertical density gradients becomes the natural «trap» for organic matter. For example, an increase in dissolved organic matter concentrations, up to 2.0 mgC L^{-1}, was observed in this layer at the section along 15°S across the Weddell Sea to the Subantarctic waters in February-March, 1989 (Romankevich and Ljutsarev 1990).

The Antarctic waters are characterized by low rates of organic matter remineralization. Therefore, the South Ocean may be considered as a

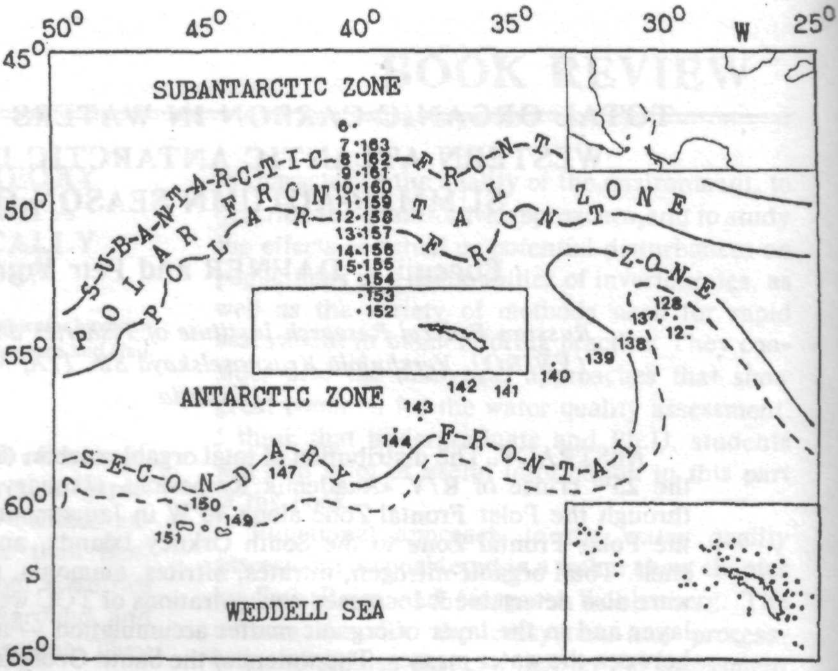

Fig. 1. Location of sections and area of work on the shelf of South Georgia Islands in January-April 1990 during the 25th cruise of RV «Akademik Knipovich»: Solid line shows the mean long-term position of the Secondary Frontal Zone; dashed line shows the position of the Secondary Frontal Zone during the period of investigation.

region of basin carbon accumulation (Smith 1991). According to Karl et al. (1987), during the growth period the total amount of organic matter transported from the euphotic zone to the layer of organic matter accumulation is about 50-200 mgC $(m^2\ day)^{-1}$. This part of organic matter is advected outside the Antarctic ecosystem and serves as feeding stock in the low latitudes.

Investigation area

Fig. 1 shows two main geographical regions of the Atlantic Antarctic and the position of oceanographic stations performed in the 25th cruise of R/V «Akademik Knipovich». Commonly the term «Antarctic» denotes the region from the Polar Frontal Zone to the Antarctic Continent coast. The Polar Frontal Zone is located between two intensified streams of the Antarctic Circumpolar Current: the north stream corresponds to the Subantarctic Front and the south one — to the Polar Front. The Polar Front is the area where sinking of dense Antarctic waters and formation of the Antarctic Intermediate Water begin.

To the south of the Polar Frontal Zone there are Surface Antarctic Waters which are called the South Periphery of the Antarctic Circumpolar Current. The interaction of the Antarctic Circumpolar Current South Periphery waters with the Weddell Sea results in formation of gradient zone — Weddell-Scotia Confluence (Gordon 1967). Because this frontal zone divides two modifications of the Antarctic Surface Waters (the Weddell and the South Periphery of Antarctic Circumpolar Current) rather than waters of different genesis, it is also called the Secondary Frontal Zone (Solyankin 1972). Another modification of the Antarctic Surface Waters occupies the shelf of South Georgia Island — the South Georgia Shelf Waters.

The main objective of the present paper is studying the organic matter distribution during the period of its accumulation, transformation and remineralization in the Polar Frontal Zone and adjacent waters, including the Secondary Frontal Zone.

Characteristics of investigation area. Materials and methods

Oceanological situation during the period of investigations

During the summer-autumn season, 1990, hydrological situation in Subantarctic and Antarctic waters was characterized by weakening of advection of the Weddell Sea waters that affected the heat content of waters in the Polar Frontal Zone and South Periphery of Antarctic Circumpolar Current. For example, at the section along 40°W at 49°S surface temperature was up to 5.40°C in January of 1990 and only 2.47°C in December of 1987 (Zozulya et al. 1990).

During the summer-autumn season, 1990, weak advection resulted in shift of the Polar Front near 40°W by 100 miles southward of its mean position for 1987-1989 (Mordasova et al. 1990). As seen from Fig. 1 the Secondary Frontal Zone was also displaced by 90-100 miles to the south from its mean long-term position (Maslennikov 1979; Maslennikov and Solyankin 1988).

Materials and Methods

The program of the 25th Antarctic cruise of R/V «Akademik Knipovich» in January-April 1990 included observations at the section along 40°W from 48°S to 53°30'S which were made in January and April, at the section from the Polar Frontal Zone (54°S, 30°W) to the South Orkney Islands (57°S), and a survey on the South Georgia shelf according to the Antarctic Committee (ANTCOM) program (Fig. 1).

Water samples were taken at the extreme points of vertical temperature profiles with the CTD-probe Neil Brown down to the 1000-m depth at the section along 40°W, and down to 500 m at the section from the Polar Frontal Zone to the South Orkney Islands. Organic carbon and nutrients (nitrites, nitrates, ammonia, phosphates, silicates) were determined in unfiltered samples with use of a flow AutoAnalyzer Technicon AA-IIC. The samples were analyzed immediately after sampling.

Organic carbon was determined by oxidation of the organic matter to CO_2 with UV irradiation plus added peroxidisulfate (Technicon 1978). After dialysis, CO_2 was detected colorimetrically using carbonate-bicarbonate buffer with phenolphthalein. The accuracy was ±0.02 mgC L^{-1} when the values were less than 1.2 mgC L^{-1}, and ±0.04 mgC L^{-1} for values greater than 1.2 mgC L^{-1}.

Total organic nitrogen was determined using the Koroleff-Valderramma method with addition of peroxidisulfate in presence of boric acid (Sapozhnikov et al. 1988). Analyses were performed by colorimetric method using a Technicon AutoAnalyzer AA-IIC (Technicon 1977).

The data on distribution of total organic phosphorus (TOP) collected during the summer of 1986 in the 23th cruise of R/V «Akademik Knipovich» (Arzhanova, Zubarevich, and Naletova, pers.comm.) were additionally used in the paper. In that cruise TOP was determined with persulphate oxidation method.

We consider total nitrogen (TN) as a sum of total organic nitrogen (TON) and total inorganic nitrogen (TIN), and total phosphorus (TP) — as a sum of total organic phosphorus (TOP) and, according to Ridal and Moore (1990), soluble reactive phosphorus (SRP), where SRP is an operationally defined value thought to represent the nutrient phosphate concentration:

$$TN = TON + TIN,$$

where $TIN = \Sigma\ (NH_3 + NO_2 + NO_3)$, and

$$TP = TOP + SPR,$$

where $SRP = PO_4$.

All data on TOC, TON and TOP in this paper were obtained for unfiltered samples.

Results

TOC at the section along 40°W

Fig. 2 shows the variation limit, mean value and number of TOC measurements. In January the processes of organic matter production continued in the photic layer of antarctic waters adjacent to the Polar Front down to 30-50 m (the lower boundary of 107% oxygen saturation) which was confirmed by increase of TOC concentration up to 2.94 mgC L^{-1}, and TON concentration — up to 29 μM (Fig. 3). The high concentrations of ammonia — up to 2.0 μM, and nitrites — up to 1.0 μM, were also observed in this layer that was evident for processes of organic matter mineralization (Fig. 4). The increase of the value of nitrite nitrogen is obviously toxic for phytoplankton, i.e. it inhibits the phytoplankton growth. So as seen from Fig. 5, the higher are concentrations of nitrite nitrogen the lower are total organic carbon values and vice versa.

The maximum content of TOC, about 2.5 mgC L^{-1}, in the 400-800 m layer was registered on the upper boundary of Antarctic Intermediate Water. The TON maximum (16-28 μM) was observed just over the TOC maximum. The increase of total organic nitrogen up to 20 μM in the 600-1000 m layer in frontal and antarctic waters was associated with organic matter sinking in the convergence zone and its accumulation on the upper boundary of Antarctic Intermediate Water.

In April the oceanological situation at the section along 40°W changed due to strengthening of antarctic water advection. Subantarctic and Polar Fronts shifted by 20-30 miles to the south and north, respectively, and the width of the Polar Frontal Zone was about 30 miles. Advection of antarctic waters corresponded to an increase in silicate content by 10 μM in the surface layer, but did not result in increase of other nutrient concentrations.

The concentration of TOC was lower (0.2 mgC L^{-1}), but compared with January the content of remineralization products of nitrogen compounds of organic matter increased. Concentration of ammonia nitrogen increased by 0.3-0.6 μM, TON — by 10 μM (by 20-30 μM in the

100-600 m layer), and the concentration of nitrites continued to be high — about 0.8-1.0 μM.

Section from the Polar Frontal Zone to the South Orkney Islands

At this section another high productive zone of the region, the Secondary Frontal Zone, was studied. The high productivity of this zone is based on Antarctic krill concentrations. As it was noted above, due to the lessening of the Weddell Sea waters advection, the Secondary Frontal Zone was shifted by 90-100 miles to the south from its mean long-term position. The section crossed the Secondary Frontal Zone between stations 128 and 137 in the north, and near the station 149 in the south. Station 150 was characterized by the Weddell Sea structure of water masses.

The photic layer in the northern part of the Secondary Frontal Zone was characterized by oversaturation with oxygen (up to 2.5%). The concentrations of TOC reached 1.8 mgC L^{-1} there, TON — 30 μM, and content of TON in TN was 60%. The concentration of ammonia nitrogen was about 1.2 μM, and nitrite nitrogen — 0.8 μM. Obviously, these data were evident for the continuing processes of production and started mineralization of organic matter.

In the southern part of the Secondary Frontal Zone oversaturation with oxygen reached 5% in the photic layer, and the TOC concentration was 0.6 mgC L^{-1}. Concentration of TON in the layer ranged from 15 to 20 μM, and content of TON in TN was 30%, i.e. inorganic nitrogen was dominant in total nitrogen.

In the central part of the section the mixed waters were observed with great influence of the Weddell Sea waters in the 50-200 m layer (stations 141 and 144), where the TOC concentrations increased up to 1.2 mgC L^{-1}. At the most southern station (station 150) the concentration of TOC in the Weddell Sea waters ranged from 0.8 mgC L^{-1} in the surface layer to 1.2 mgC L^{-1} near the upper boundary of the Antarctic Bottom Water (about 200 m). The Weddell Sea water were characterized by relatively low content of TON.

In the South Periphery Antarctic Circumpolar Current water (stations 140, 142, 143, and 147) concentrations of TOC were rather low except for station 142, where they increased up to 1.2 mgC L^{-1} on the upper boundary of Antarctic Bottom water. The Antarctic Circumpolar Current water were also characterized by low values of TON, about 5 μM, and the content of total inorganic nitrogen in total nitrogen was about

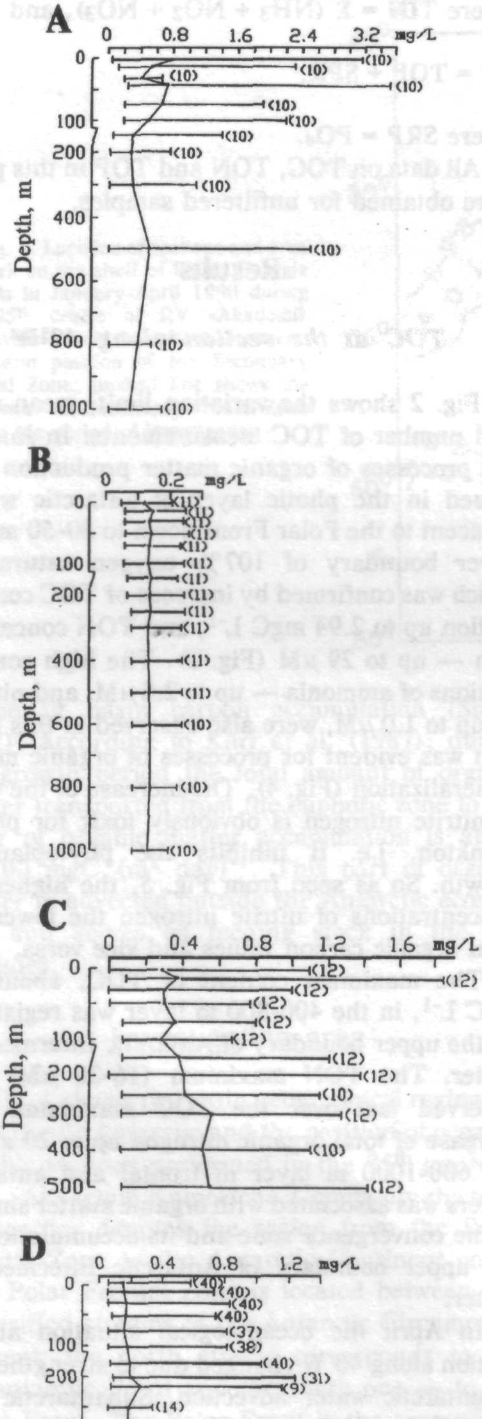

Fig. 2. Integral curves of TOC vertical distribution (mgC L^{-1}): along the 40°W section in January (A) and April (B); along the Polar Frontal Zone — South Orkney Islands section (C); on the shelf of South Georgia Island (D).

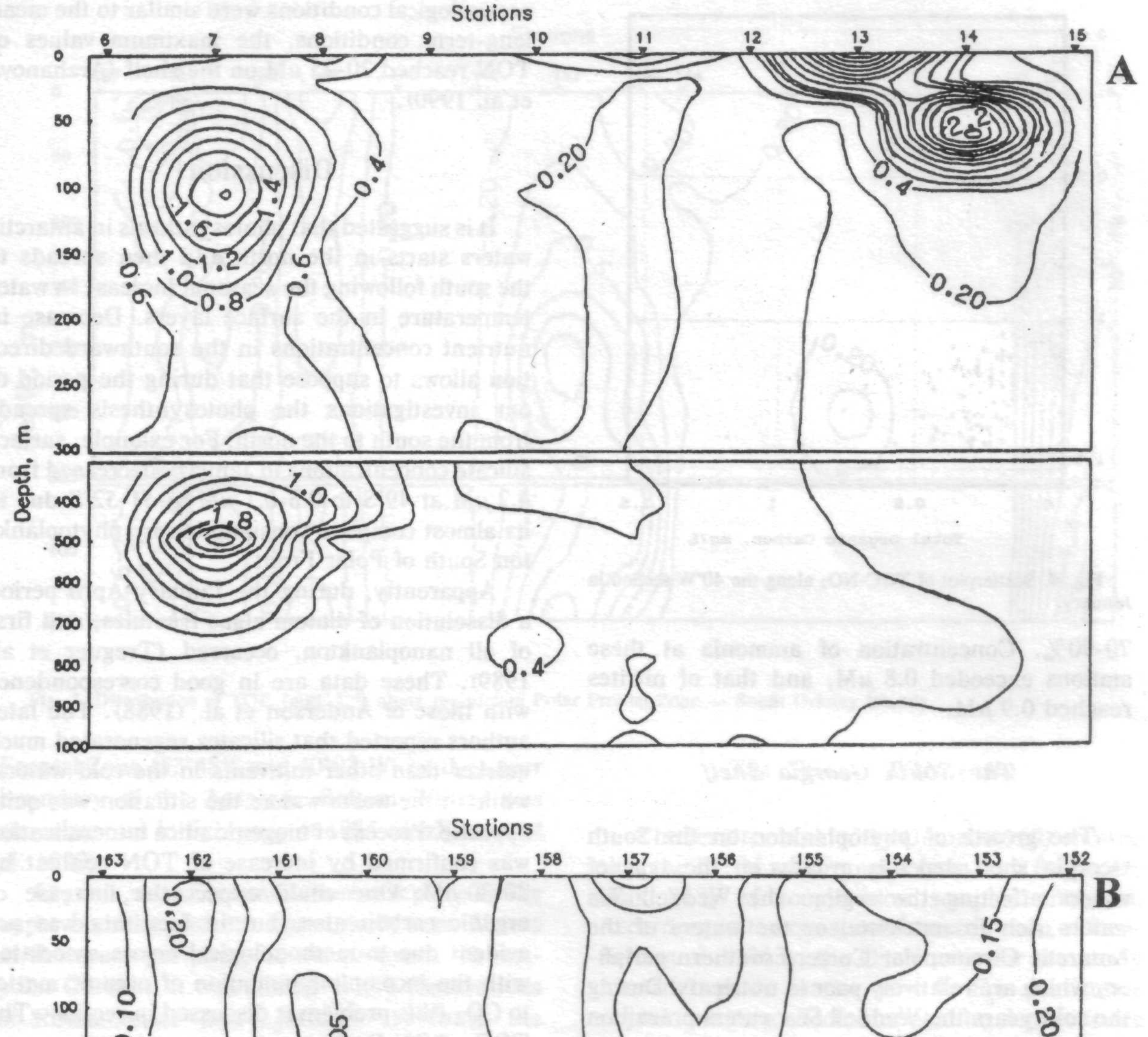

Fig. 3. Distribution of total organic carbon (mgC L⁻¹) along the 40°W section in January (A) and April (B).

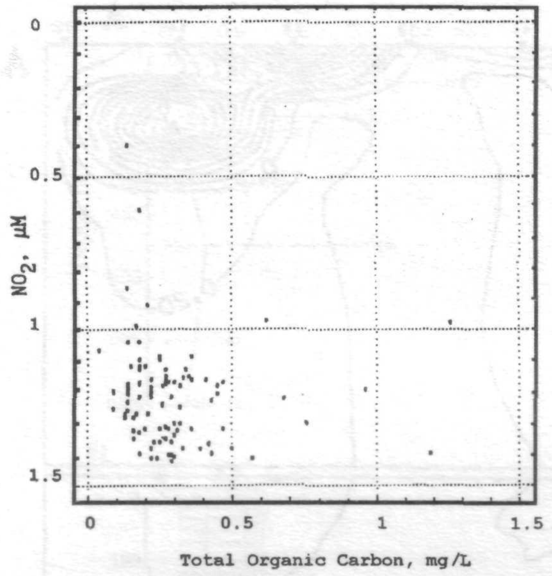

Fig. 4. Scatterplot of TOC-NO_2 along the 40°W section in January.

70-90%. Concentration of ammonia at these stations exceeded 0.8 µM, and that of nitrites reached 0.9 µM.

The South Georgia Shelf

The growth of phytoplankton on the South Georgia shelf depends greatly on the type of waters affecting the region: the Weddell Sea waters rich in nutrients, or the waters of the Antarctic Circumpolar Current southern periphery which are relatively poor in nutrients. During the cold years the Weddell Sea waters prevail on the shelf, while during the warm years the waters of the southern periphery of Antarctic Circumpolar Current advected in this region (Maslennikov 1976). The primary production of the shelf waters was assessed as 2.1 mgC m^{-2} in spring, 1.4 mgC m^{-2} in autumn and 0.1-0.2 mgC m^{-2} in winter for the period 1979-1988 (Shulyakovsky 1990). At the same time, production of oceanic waters adjacent to the shelf was 1.5-2.0 times lower.

During the period of our investigations the Antarctic Circumpolar Current waters prevailed on the shelf affecting the nutrient concentrations. The similar situations were observed in the spring-summer seasons of warm years 1968 and 1969 (Arzhanova, 1974).

Shelf and slope waters around the South Georgia Island were characterized by low content of TOC — about 0.2 mgC L^{-1}. At the same time, rather high concentrations of various nitrogen forms were observed. Ammonium nitrogen reached 1.6 µM, nitrite nitrogen — about 0.5 µM, and TON — 20 µM. In February 1985 when oceanological conditions were similar to the mean long-term conditions, the maximum values of TON reached 20-25 µM on the shelf (Arzhanova et al. 1990).

Discussion

It is suggested that photosynthesis in antarctic waters starts in the north and then spreads to the south following the seasonal increase in water temperature in the surface layers. Decrease in nutrient concentrations in the southward direction allows to suppose that during the period of our investigations the photosynthesis spreads from the south to the north. For example, surface silicate concentrations in January decreased from 4.2 µM at 49°S to 0.3-0.1 µM at 51-52°S due to its almost complete consumption by phytoplankton South of Polar Front.

Apparently, during the January-April period a dissolution of diatom algae frustules, and first of all nanoplankton, occurred (Treguer et al. 1989). These data are in good correspondence with those of Anderson et al. (1988). The later authors reported that silicates regenerated much quicker than other nutrients in the cold waters, while in the warm waters the situation was quite opposite. Process of biogenic silica mineralization was confirmed by increase of TON content by 20-30 µM. One could expect the increase of organic carbon also, but in fact this was not evident due to methodological errors associated with the incomplete oxidation of organic matter to CO_2 (this problem is discussed in section «The TOC : TON Ratio»).

Spreading of photosynthesis processes from the north to the south is often noticed in Antarctic waters. For example, it was observed in the area near the Antarctic Peninsula in December 1986 — March 1987, when concentrations of chlorophyll *a* increased southwards up to 20 mgC L^{-1} (Holm-Hansen et al. 1987).

Our investigations in the summer-autumn season of 1990 coincided with period of low production and with active destruction of organic matter by the bacterioplankton. The organic matter produced during the period of vegetation sank and accumulated on the vertical boundaries of Antarctic Intermediate Waters and Antarctic Bottom Waters.

The increase of total N_{org} up to 20 µM in the layer of 600-100 m of the Antarctic and frontal waters of the Polar Frontal Zone was associated with organic matter sinking in the zone of convergence with further accumulation on the vertical boundaries of the Antarctic Intermediate Water. Accumulation of TON south of the Polar

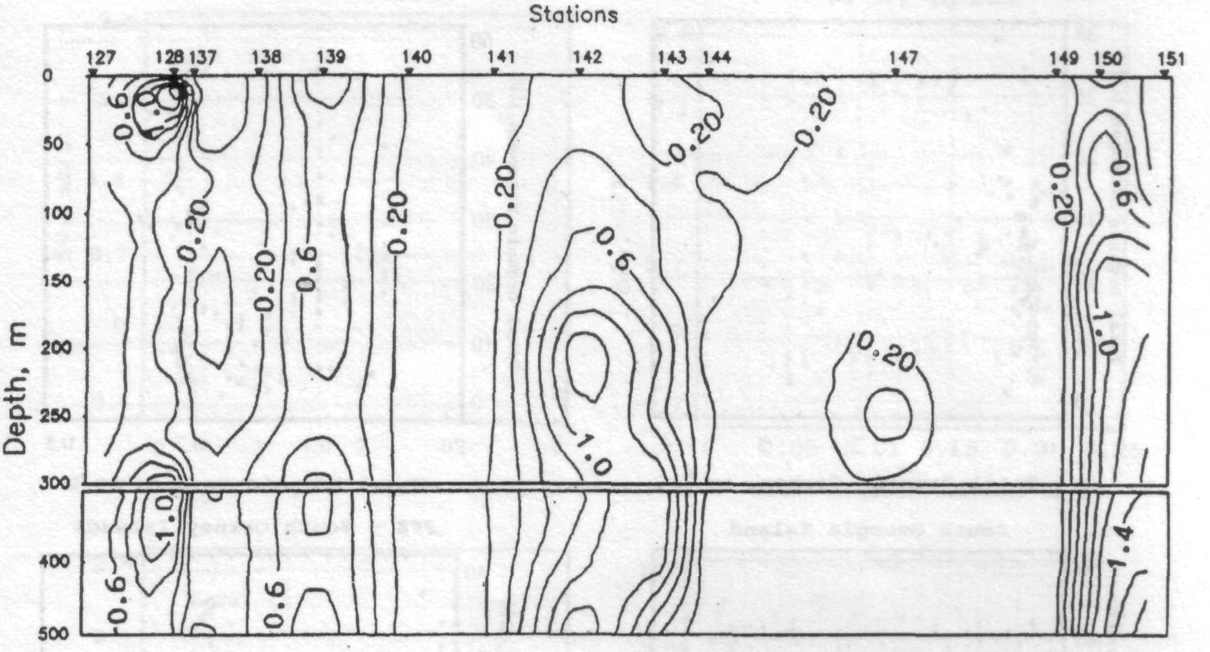

Fig. 5. Distribution of TOC (mgC L^{-1}) along the section Polar Frontal Zone — South Orkney Islands.

Frontal Zone (53°48′S and 40°03′W) on the upper boundary of the Antarctic Bottom Waters was also observed in February of 1985 (Arzhanova et al. 1990).

Organic matter accumulation took place on the upper boundary of the Antarctic Bottom Waters at the south periphery of the Antarctic Circumpolar Current. It was similar to the observations of Romankevich and Ljutsarev (1990) at the section along 15°W across the Weddell Sea up to subantarctic waters.

During the period of spring phytoplankton blooming in the antarctic waters the low water temperatures prevent the destruction activity of bacterioplankton. As a result, accumulation of assimilated organic matter occurs (Sorokin and Mamaeva 1988). The increase in temperature in summer results in heightening of bacterioplankton activity. By this, bacterioplankton uses about 40% of consumed organic carbon for its growth in the Antarctic (Bjornsen and Kuparinen 1991). Therefore, the contribution of bacteria to the total production is great, and during autumn (in March) the production of bacteria exceeds the total production of autotrophic algae (Sullivan et al. 1987). Apparently, period of our research coincided with active mineralization of nitrogen compounds of organic matter in the Antarctic Circumpolar Current waters, i.e. total content of mineral nitrogen amounted to 70-90% of total nitrogen.

The TOC : TON ratio

The results obtained by Omori (1969) showed that the C : N ratio ranged from 3 to 8 in more than 80% of zooplankton samples analyzed. According to the quasistoihiometric ratio of Redfield et al. (1963), the C : N ratio for the newly formed organic matter is 6.6. For particulate organic matter collected under the Antarctic ice it was obtained that concentration of phosphorus was higher and that of nitrogen was lower in summer; during winter values of both phosphorus and nitrogen were lower than in the Redfield ratio (Matsuda et al. 1992). At isopycnes surfaces of $\sigma_t = 27.0\text{-}27.2$ in the Atlantic Antarctic, where the organic matter accumulation occurs, the C : N : P ratios were (102±7) : (16.7±0.7) : 1 and (95±10) : (16.7±1.2) : 1 (Takahashi et al. 1985), correspondingly.

The C : N ratio depends greatly on the method of their determination. For example, this ratio ranged from 5.6 to 6.8 in the surface waters of the Pacific ocean if dissolved organic carbon (DOC) with molecular weight of 4,000-22,000 Daltons was determined by method of oxidation with peroxidisulfuric acid, while it was 7-12 when dissolved organic carbon was determined by wet or UV oxidation (Williams and Druffel 1988). According to results obtained with use of three different methods of dissolved organic carbon determination (photo oxidation, dry oxidation, and persulphate oxidation), its distribution on

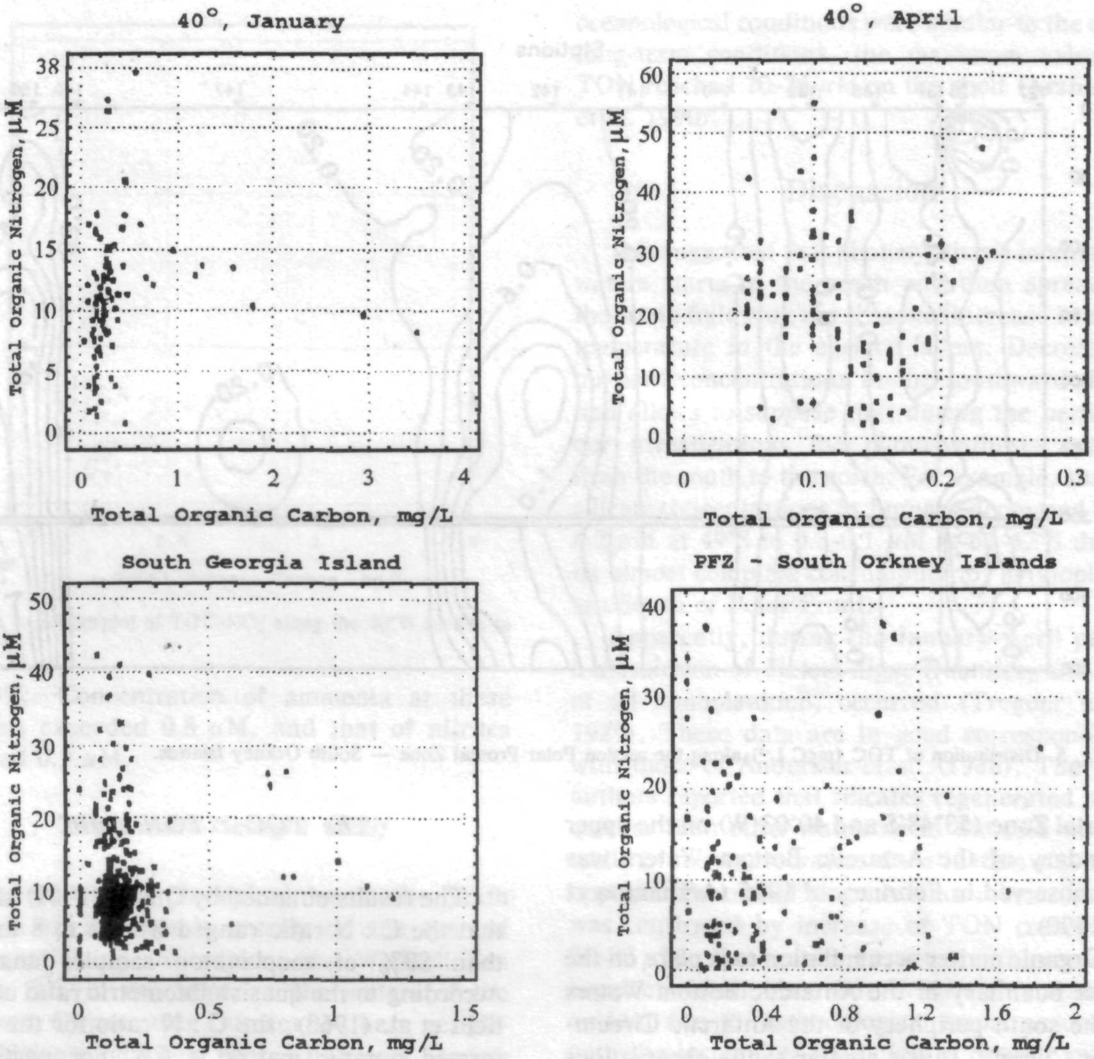

Fig. 6. Scatterplot of TOC : TON (January — April, 1990).

the Scotia Sea shelf was even with values of 0.7-0.9 mgC L^{-1}. The results of all the three methods were comparable (Gershey et al. 1979). By this, all the three methods produced higher concentrations in filtered (DOC) samples than in unfiltered (TOC). In equatorial Atlantic the C : N ratio in particulate organic matter ranged from 18.5 at the surface to 9.3 at depth of 1 m (Menzel 1966).

Determination of organic carbon by method of high temperature combustion showed that oxidation of organic matter depends on temperature of combustion, the depth of sample taking, and size of organic matter particles (Suzuki et al. 1985, Sugimura and Suzuki 1988). The oxidation is more complete at the temperature above 600°C for organic matter samples which have molecular weight less than 1800 Daltons and are taken in the surface layers.

Parsons (1982) citing on Porter (1946), pointed out that the C : N ratio less than 1 was characteristic of urea, while for proteins it was 4.5; the latter might be attributed to some bacterial species as well.

As seen from Table 1 and Fig. 6, the TOC : TON ratio varies greatly. The ratio tends to decrease from January to April, which is apparently associated with transformation of organic matter from spring to autumn season. The largest changes were observed at the section Polar Frontal Zone — South Orkney Islands.

Table 1. TOC : TON Ratio in January-April 1990.

Investigation Area	TOC : TON		
	max	min	mean
40°W, January	7.7	0.8	3.9
40°W, April	4.9	0.1	0.8
Shelf of South Georgia Island, February	2.3	0.1	0.2
PFZ — South Orkney Islands, March	9.8	0.1	2.8

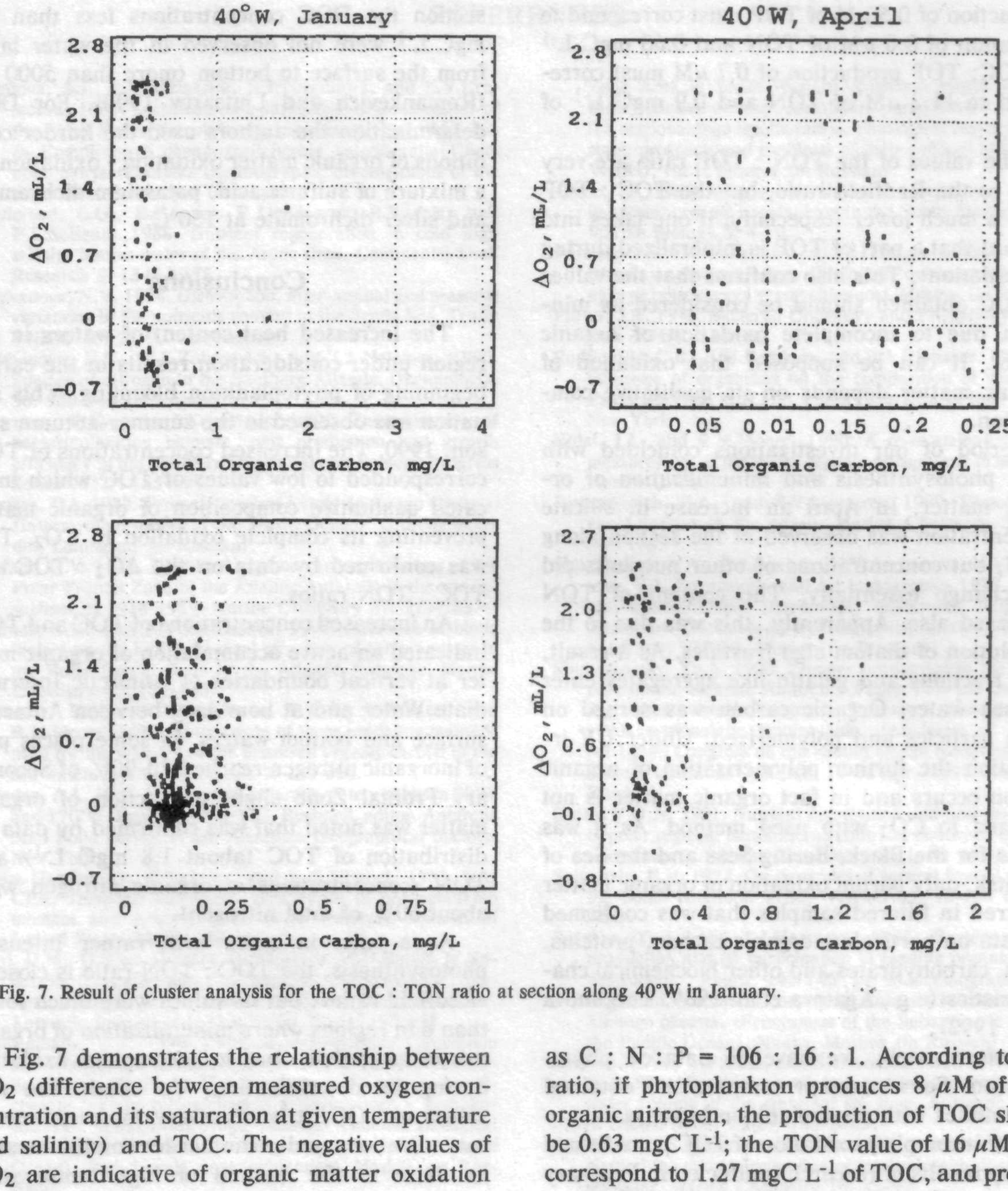

Fig. 7. Result of cluster analysis for the TOC : TON ratio at section along 40°W in January.

Fig. 7 demonstrates the relationship between ΔO_2 (difference between measured oxygen concentration and its saturation at given temperature and salinity) and TOC. The negative values of ΔO_2 are indicative of organic matter oxidation processes. The low values of ΔO_2 would have corresponded to high concentrations of total organic carbon, but this was not so in fact. Obviously, this is associated with imperfection of the method used.

The incomplete oxidation of organic matter is confirmed by the TOC : TON ratio also. In the whole range of TON change (Fig. 6), the content of TOC varied slightly. The only exceptions were the TOC distribution at section along 40°W in January and at section Polar Frontal Zone — South Orkney Islands, where processes of production and destruction of organic matter were observed simultaneously.

To assess the degree of incompleteness of the TOC combustion, we used the «Redfield ratio» as C : N : P = 106 : 16 : 1. According to this ratio, if phytoplankton produces 8 μM of total organic nitrogen, the production of TOC should be 0.63 mgC L^{-1}; the TON value of 16 μM is to correspond to 1.27 mgC L^{-1} of TOC, and production of 32 μM of TON requires TOC production of 2.54 mgC L^{-1}. As seen from Fig. 6, these ratios were close to above values at the section from the Polar Frontal Zone to the South Orkney Islands, and at the section along 40°W in January, i.e. in regions where processes of organic matter production continued during the period of investigations (the Redfield ratio describes the relations for the newly formed organic matter).

The same can be followed when assessing the TOC : TOP ratio. The maximum concentration of TOP, up to 0.7 μM, was observed near the South Georgia Island, the background values were 0.5 μM in the Scotia Sea and Bransfield Strait (Arzhanova, Naletova and Zubarevich, pers. comm.). According to the «Redfield ratio», production of 0.5 μM of TOP must correspond to formation of 8.0 μM of TON and 0.63 mgC L^{-1} of TOC; TOP production of 0.7 μM must correspond to 11.2 μM of TON and 0.9 mgC L^{-1} of TOC.

The values of the TON : TOP ratio are very close to the Redfield ratio, but the TOC : TOP ratio is much lower (especially, if one takes into account that a part of TOP is mineralized during its oxidation). This also confirms that the values of TOC obtained should be considered as minimum due to incomplete oxidation of organic matter. It can be supposed that oxidation of organic matter depends on its qualitative composition.

Period of our investigations coincided with weak photosynthesis and mineralization of organic matter. In April an increase in silicate concentration was observed at the section along 40°W, but concentrations of other nutrients did not change essentially. The content of TON increased also. Apparently, this was due to the dissolution of diatom alga frustules. As a result, fecal fractions and gelatin-like aggregates enter the sea water. Organic carbon was sorbed on these particles and polymerized. Under UV irradiation the further polymerization of organic carbon occurs and in fact organic matter is not oxidized to CO_2 with used method. As it was shown for the Black, Bering Seas and the Sea of Okhotsk, only partial oxidation of organic matter occurred in filtered samples that was confirmed by data on particulate organic carbon, proteins, lipids, carbohydrates and other biochemical characteristics (e.g., Agatova et al. 1989, Torgunova et al. 1992).

Unfortunately, we have no data on phytoplankton. So we cannot compare the obtained TOC values with phytoplankton biomass.

The incomplete oxidation of TOC is confirmed also by results of research conducted in February — March 1989 at the section along 15°W. At this section the DOC concentrations less than 0.9 mgC L^{-1} were not observed in the water layer from the surface to bottom (more than 5000 m) (Romankevich and Ljutsarev 1990). For DOC determination the authors used the harder conditions of organic matter oxidation - oxidation by a mixture of sulfuric acid, potassium dichromate and silver dichromate at 130°C.

Conclusions

The increased heat content of waters in the region under consideration results in the earlier beginning of phytoplankton blooming. This situation was observed in the summer-autumn season, 1990. The increased concentrations of TON corresponded to low values of TOC which indicated qualitative composition of organic matter preventing its complete oxidation to CO_2. This was confirmed by data on the ΔO_2 : TOC and TOC : TON ratios.

An increased concentrations of TOC and TON indicated an active accumulation of organic matter at vertical boundaries of Antarctic Intermediate Water and at boundary between Antarctic surface and bottom waters. In some places part of inorganic nitrogen reached 70-90% of Secondary Frontal Zone slight production of organic matter was noted that was confirmed by data on distribution of TOC (about 1.8 mgC L^{-1}) and TON (concentrations of organic nitrogen were about 60% of total nitrogen).

As a rule, in areas with rather intensive photosynthesis, the TOC : TON ratio is close to «Redfield ratio», but its values were much lower than 6 in regions where mineralization of organic matter prevailed, due to incomplete oxidation during its determination. To obtain the real values of TOC, it is necessary to determine its concentrations under the harder conditions such as those in the method of high temperature combustion of Suzuki and Sugimura (1988).

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Валовый органический углерод в водах Юго-западной части атлантического сектора Южного океана в летне-осенний сезон 1990 года.

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РЕЗЮМЕ. В 25 рейсе НПС «Академик Книпович» (январь-апрель 1990 года) изучали распределение валового органического углерода (ТОС) на разрезах через Полярную фронтальную зону по 40° з.д. в январе и апреле, на разрезе от ПФЗ до Южных Оркнейских островов и на шельфе о. Южная Георгия. Кроме ТОС производили определеление валового органического азота, азота нитратов, нитритов, аммония, фосфатов и кремния. Увеличение содержания ТОС наблюдали в фотическом слое и в слоях аккумуляции органического вещества — на вертикальных границах водных масс. Воды о. Южная Георгия характеризовались невысоким содержанием ТОС около 0.2 мг/л.